

Comments of the Center for Wireless Network Security (WiNSeC)  
Washington County Consolidated Communications Authority  
Tualatin Valley Fire and Rescue  
and Fire Chief Jeff Johnson, Chair of the Oregon Statewide Interoperability Executive  
Council

Before the  
Federal Communications Commission  
Washington, D.C. 20554

In the Matter of	)	
Promoting Efficient Use of Spectrum Through	)	WT Docket No. 00-230
Elimination of Barriers to the Development of	)	
Secondary Markets	)	

December 5, 2003

WiNSeC is an academic research and development center located at Stevens Institute of Technology. Part of WiNSeC's mission is to provide a visionary, future-oriented program of research, testing and policy development focused on technological innovation, capacity expansion, and voice, data and imagery demonstration for public safety communications. Tualatin Valley Fire & Rescue (TVF&R), managed by Fire Chief Jeff Johnson, is a nationally recognized fire service district protecting the majority of Washington County and portions of Clackamas and Multnomah counties in Oregon. TVF&R and the other public safety providers throughout Washington and Clackamas County receive public safety voice and data communications from the Washington County Consolidated Communications Agency (WCCCA). Within Washington and Clackamas Counties are suburban, urban, and rural areas including some of the wilderness areas in Oregon Coastal mountain range and the rolling hills and river basins of the Western Willamette Valley. The Oregon Statewide Interoperability Executive Council (SIEC) represents local, state, and tribal governments in policy issues related to public safety radio for the State. TVF&R's Fire Chief Jeff Johnson also serves as the chair of the SIEC by gubernatorial appointment as well as the Vice-President, and incoming President of the Western Fire Chiefs Association.

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## 1. Overview of Comments

Since the Spectrum Policy Task Force Report in November 2002<sup>1</sup>, little effort has been put toward defining the meta-layer legal, regulatory, operational and band-management paradigm for public safety communications systems within a flexing, dynamic, spectrum access environment. WiNSeC suggests that a series of focused efforts in policy, technical, and economic research are necessary to lay a sound foundation and framework for further development in cognitive and software defined radio design, spectrum leasing schemes and band management.

A more thorough examination of the technical and policy issues is needed to determine the best approach to interruptible spectrum management and licensing. Although designated public safety spectrum bands continue to be a necessity, opportunity exists for public safety to benefit from secondary markets. Precursors for realizing these benefits are the development and introduction of advanced radio technologies such as software-defined radio and cognitive technologies, a clear and precise method of allocating spectrum, and a clear national policy to prioritize public safety communications access to infrastructure and spectrum resources.

Secondary spectrum markets, cognitive radio and software-defined radio are in early phases of the development cycle. Though manufacturers and developers are tackling the challenges of physics; the legal, regulatory and operational challenges, particularly for public safety, are barely on the policy radar. WiNSeC suggests that the FCC can help; and has already begun to create an environment where it will be possible to work through the spectrum reform issues that concern public safety in a fresh, future-oriented and cross-disciplinary manner.

There are important public policy arguments and ideas that need to be posed and vetted regarding who, and how, various players can access the spectral property rights of another before technology can properly advance the social goals. As the Commission noted in the current Notice, “the overarching goal of spectrum policy is to maximize the public benefits that are derived from spectrum-based services and devices”.<sup>2</sup> The Spectrum Policy Task Force recognized, in its report, that there are “clear, non-market public interest benefits” to certain uses of spectrum, and that when defining such benefits, it is important to distinguish between “special interest” and “public interest” and to establish a “high bar for any service to clear” prior to its recognition as a public interest spectrum use<sup>3</sup>. Although market forces will be important, the Commission appears to have clearly recognized that the reform of spectrum access rights and obligations, and the associated operational mechanics of regulatory reform, standards-setting and leasing, cannot be vetted entirely with a “market forces” paradigm.

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<sup>1</sup> Spectrum Policy Task Force Report ET Docket No. 02-135, November 2002

<sup>2</sup> WT Docket No. 00-230, paragraph 215.

<sup>3</sup> FCC Spectrum Policy Task Force Report, p. 41

The issue of how spectrum is allocated is of paramount importance to public safety. Without a national policy concerning public safety access, availability and reliability; the public safety community is legitimately concerned that reforms will only serve market efficiency. Since public safety is not a market, but a public service, it will not benefit fully from the market efficiency paradigm. This means the public's interest will not be fully served by the market efficiency paradigm either.

This problem is apparent in the current allocation of frequencies to public safety in the 700 MHz band. Although this much needed public safety spectrum has been reserved for years, it is not in the control of the public safety community. It is still occupied in many markets by broadcasters, with no date certain for them to vacate. Since there is no actual allocation, vendors cannot justify the expenditure of economic resources for introducing public safety equipment for the band. Instead, they can extend the product lifecycle of equipment introduced a decade earlier. When the new equipment does become generally available, the procurement cycle will require another three to seven years. Though this may be appropriate market behavior for broadcasters and vendors, the underlying federal policy actually perpetuates scarcity of spectrum and innovation for public safety. As long as public safety has to wait decades for usable spectrum allocations, and more years for equipment to operate in that spectrum, it is unlikely that it will see the ability to lease any of its future "expansion" spectrum as rational.

**2. There is a need for a national policy and a national vision of a public safety communications architecture that breaks the previous paradigm of isolated spectrum access. Public safety needs equivalent priority access to the nation's communications infrastructure as the "lights and sirens" priority it enjoys on other national infrastructure, notably federal, state, and local highways, streets and routes.**

**2.1 Public safety communications is not a "market"**

US Spectrum policy currently favors the most "efficient" use of spectrum under a free-market set of efficiency standards. Public safety communications cannot be provided in the manner that "efficient market-oriented" services develop or operate. Public Safety operates in a different paradigm, where incalculable public interest is served when both spectrum and infrastructure policy creates complete availability for police, fire and 911 services, to the population, no matter its lack of density, its lack of income, or its remoteness.

The first national policy goal needs to be to furnish spectrum to the first responders of any agency wherever they are, whenever they need it. Until we articulate this paradigm as a priority of national spectrum policy, we inherently continue to support the isolation and secondary status of public safety. If public safety users remain isolated in spectrum and in spectrum policy, we cannot make spectrum decisions and infrastructure investments to correctly support them.

A second goal is to dramatically reduce the cost and limitations of end user devices, and replace “public safety radios” with any device. First responders need secure, reliable communications over their PDA, cellular phone, wireless laptop or radio to communicate across *both commercial and public safety spectrum bands*, AND *commercial and public safety wireless infrastructure*. The FCC should focus on promoting development of technologies which can recognize, authenticate, and prioritize public safety transmissions

## **2.2. Interoperability problems are, in part, a result of traditional silos created in history and promulgated in policy**

A third goal is to reduce duplicative, un-leveraged investment in backbone infrastructure. Where we currently segment public safety and commercial users at the network physical layer and then burden local government with the expense of massive network infrastructures, we should move toward the secure segmentation and prioritization of public safety at a higher layer, and share facilities across the nation.

One important characteristic of public safety traffic, especially voice traffic, is its density and compact nature—compared to most commercial public uses of spectrum for voice. While a typical cellular telephone call may be 20 minutes in length, the average length of a public safety voice transmission is well under 15 seconds. Thus, the short, bursty, but critical profile of public safety spectrum access makes it easy to draw an analogy between the “lights” and “sirens” use of the streets, and the potential for “lights and sirens” use of commercial voice and data infrastructure.

Voice and data communication use is growing not only as a commercial service in all sectors of the population, but as a law enforcement and public safety tool as well. Today, a police cruiser or fire vehicle is likely to have over \$10,000 worth of communications equipment installed before it is put into service. The amount of time a patrol officer or firefighter spends using communications devices on a shift is up more than 500% than at the time most public safety systems were designed and installed. The obsolete public safety systems in use today are being stressed by this growing reliance on Information Technology in the day-to-day work of public safety personnel.

The stress on public safety information systems evidences itself not only in the need to add channels to these systems to increase capacity, but also in the real requirement to add infrastructure to gain both coverage and capacity. However, the addition of infrastructure adds layers of complexity to system management, and forces the capital and operating costs of systems out of the range of achievability for the local governments attempting to pay for them. This is a critical problem in both rural areas, where the tax base cannot finance radio infrastructure, and in metropolitan areas where coverage “holes” are increasingly unacceptable, and where urban boundaries are expanding faster than radio systems.

Radio coverage for public safety networks that was adequate in many geographic regions is actually shrinking. This is as a result of both population growth and growth in demand for mobile communications. This paradox is especially vexing to first responders, whose

job becomes more complex as the RF environment becomes more hostile. So as steel girder buildings, underground parking lots and other structures are added in a community, radio coverage disappears on that real estate. As cellular towers are added, the radio environment begins to overpopulate enough to cause first responder systems, not designed to filter out these “neighborhood” transmissions, to simply shut down because they cannot hear their control channel. The shrinking zones around a public safety transmission site can change overnight. Cellular towers are going up so fast in metropolitan markets that it is not uncommon for hundreds of commercial transmit antennas to be added in the typical public safety coverage footprint in a year. Instead of benefiting from commercial wireless deployment, public safety is more often disadvantaged by it. In a paradox caused by isolation, public safety loses ground when more commercial capability is deployed.

### **2.3. Isolation of Public Safety Communications from Commercial Systems has been damaging.**

We know that public safety systems deploying locally is important to local officials and first responders to preserve operational protocols. Yet today, the privacy of the network for the end user, its security and its dispatch protocols are all manageable at the operations protocol layers of the network, even on a shared network, even on a commercial network. The problem of interoperability is not simply a spectrum problem, but also a result of historic behavior in all sectors.

The lack of a national policy for public safety communications, the market-driven development of commercial systems, and the absence of open standards in public safety equipment have left localities with no better option than to build geographically isolated, stove-piped, proprietary systems with limited capability to interoperate.

The end result is that a state government may own up to 8 statewide radio infrastructures. A large city may own four. A county may also own four. The next county over may own four more. Given this factorization, these systems are guaranteed to have far less capability and capacity than comparable consumer systems, the end-user devices will cost more than 10 times what a consumer pays, and the coverage characteristics of the systems will be inferior to commercial systems.

Thus, in a major city, a first responder may carry several radios to be able to communicate on any of the systems that may be the command system for an event. Today a new market for “interoperability” black boxes is being created to allow the isolated radio systems built specifically to serve only one class of users (say firefighters) to talk to another class of users (say police).

In more rural areas, where the tax base is smaller, and the geography is vast, there may be a very limited capacity system serving local responders, even though there are several statewide systems, each dedicated to a single state agency. In a catastrophic event, like a wildfire, responders may arrive with radios to provide aid, but have no system to transmit over.

## **2.4. Multiple Systems in a market are inefficient.**

Eventually, the ability to lease public safety or other government spectrum and/or infrastructure, (towers, rack space, buildings, power systems) to commercial entities may be an attractive way to incent local governments and public safety agencies to consolidate elements of their radio systems and radio system operations. If, multiple agencies could migrate to a single, high capacity, high coverage radio system in a geographic area, queuing theory suggests that the need for actual frequency assignments to public safety would go down. For instance, in 2002, the City of Portland provided the Office of Engineering and Technology at the FCC data comparing the number of frequency assignments it would take to accommodate the 100 + public safety and public service agencies served by the City's consolidated radio utility. Without the consolidated system, the number of channel assignments necessary to serve the Portland market would have to double. Along with the additional channels come the operations costs, hardware costs and other system costs, which would also be duplicated. If communities could lease a portion of their future-need "stockpiled" spectrum to finance a consolidation and improvement program, then there could be an incentive to move to this more spectrally and economically efficient mode. However, this will only become a rational option if public safety agencies have the ability to augment dedicated public safety spectrum with an immediate "ruthless lights-and-sirens pre-emption" on commercial spectrum during an emergency to accommodate the expected surge in public safety traffic. Developing technologies could provide means for just-in-time pre-emption of portions of a user's spectrum, of which the impact would either be a data rate reduction or the temporary reduction in the number of channels/callers. Such a preemption scenario would not require entire blocks of spectrum, or the complete spectrum resource of a user.

A significant problem for public safety will be the reliability and survivability of any system resources it accesses. Since a lights and sirens preemption would take place during a surge of public safety communications activity, it would include events that may have compromised commercial systems abilities to operate; either because their facilities have been damaged (for instance, in an earthquake) or when consumer use is also high (which will happen in a riot, a natural disaster, an attack). Unless private commercial systems are constructed with public safety levels of reliability and redundancy, and accommodate public safety calls as priority traffic, a public safety operation could not count on them as a substitute for stockpiled public safety spectrum resources.

## **3 Our national policy must encourage the interruptible use of spectrum and systems for national defense and public safety.**

To attack the issues of interoperability, reliability, and spectrum allocation for public safety productively we must begin by developing and implementing a national policy. The FCC should promote a program of data collection and spectrum measurement to support flexible spectrum goals with evidence. Data is needed to show that no sector of the user community will be disadvantaged when the time dimension of spectrum allocation is activated in policy.

WiNSeC's position is that our national policy on public safety communications systems should not only protect portions of the spectrum for exclusive public safety licensing, but should also emphasize the primary importance of public safety transmissions across commercial spectrum bands. We propose a "lights and sirens" access policy that includes compensation. This model would create the ability for government to negotiate terms to lease or purchase, on a "lights and sirens" basis, the ability to traverse spectrum and infrastructure in the same way that fire apparatus and police cruisers can displace private and commercial traffic on the highway to accomplish their mission.

Local government needs radios that can talk over any available (fallow) frequency in a secure manner back to their dispatch center or talk group. On a day-to-day basis in metropolitan areas this is efficiently done on a private radio system operating specifically for public safety. The advantages of a separate public safety system are that its capacity is guaranteed, control is guaranteed, and it can be engineered with several layers of redundancy. However, redundancy and stockpiled emergency capacity are expensive. If such investments were shared across public and commercial infrastructure, the ability to access commercial infrastructure for backup, as "just in time" inventory for lights and sirens emergencies is potentially more economical and serves the public interest.

To the degree that public safety users could be assured of immediate, as well as primary or priority access to a commercial system's resources, it could reduce their need to stockpile public safety spectrum inventory for emergencies. Indeed where a public safety spectrum inventory exists, it could be leased to commercial service providers, generating revenues for the community and managed under a regime that provides undisputed priority for public safety communications when necessary.

### **3.1 Accordion Spectrum rights, or "Easements" and Lights and Sirens Access creates more efficient use of the spectrum.**

Since public safety traffic is by nature, short, bursty, and experiences infrequent but unpredictable spikes, a benefit could come to public safety by leasing access to a portion of its frequencies to commercial carriers, using a put and call leasing mechanism as suggested in this Notice on Secondary Markets, and in the Marcus, Bykowski White Paper "Facilitating Spectrum Management Reform via Callable/Interruptible Spectrum".<sup>4</sup> This might be especially beneficial for those frequencies suitable for commercial data service. Public safety will rarely find itself in the position of having licensed frequencies that it has no need for. Public safety systems must inherently "stockpile" future emergency capacity, unless that capacity can be reliably acquired in a "just in time environment." The problem with acquiring it through a lease with commercial entities is that public safety becomes the secondary user, rather than the primary access holder. Because of the critical nature of public safety activities, and the associated liability, public safety would not be wise to become a secondary user, except in the scenario where its use is secondary, and another primary communications path (the private system) is there as insurance.

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<sup>4</sup> Office of Plans and Policy, Office of Engineering and Technology, FCC, September 2002

A more palatable way for public safety to enter the secondary spectrum market is as a primary or priority user. Though the licensee may not be public safety, public safety preemption would be mandatory, and automatic, up to a certain threshold. This is the lights and sirens preemption operating over an “accordion flex” of spectrum rights.<sup>5</sup> Just as a cruiser, ambulance or fire truck pre-empts traffic on a street, interrupting only the intersection it is passing—not shutting the street down, not inconveniencing traffic flow—simply going ahead of everyone else, until they get to their destination. The term “accordion flex” refers to the ability of public safety spectrum users to “expand” or “flex” into commercial or shared spectrum to accomplish a single transmission and then “contract” back to their exclusive spectrum as busy conditions subside. Secure accordion spectrum rights on the commercial cellular and RF networks would be extraordinarily useful to public safety.

In fact, public safety traffic patterns are likely to be complimentary to many commercial user patterns. For instance, the busiest times for a public safety radio system are Friday and Saturday night—midnight to 3 a.m. (bar closing time). Other predictable traffic patterns exist, and suggest that conventions could be developed to manage traffic of both public safety and commercial users across bands based on usage patterns in a market.

Another requirement, then, for the development of a national policy on public safety radio would include the development of reliable traffic engineering and self-correcting spectrum allocations across the country. A very basic lesson learned during the last several years, is that as wireless technology gains footprint, and as the price of end-user access to spectrum declines, the demand of any individual user increases. Simply put, when it’s reasonably convenient to access spectrum, we each access much more. The costs for consumers have dropped so low, that teen-agers and soccer moms are snagging spectrum simply to transmit social messages. Yet, public safety and first responder cost has remained so high, with no price drop in end-user devices in over 10 years, that many fire and police departments still issue radios out of a pool, and may limit one to a car carrying two officers. SAFECOM has estimated the cost of complete replacement costs for Local/State/Federal land mobile radio systems to be in excess of \$18 billion.<sup>6</sup>

The solution is to get capable yet low-cost devices in the hands of public safety personnel, and design a system of secure authentication, reliable public safety grade of service backbone infrastructure improvements, and deploy them. Since public safety represents such a small market, given their reduced buying power and sheer small numbers in relation to commercial markets, such a transition will require national policy based incentives or regulatory requirements. It is unlikely that commercial carriers who hold spectrum and invest in infrastructure will be willing to “share” that infrastructure with public safety when it could be earning more revenue shared with teenagers and soccer moms. But the real cost overall to the citizens would be far less than it is today.

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<sup>5</sup> FCC Spectrum Policy Task Force Report, p.44

<sup>6</sup> “Public Safety Wireless Interoperability” presentation, SAFECOM, October 24, 2003.

- 4. For public safety, the development and introduction of opportunistic technologies, particularly cognitive radios, and public safety's participation in secondary use of spectrum are intrinsically linked. Beyond equipment, the nation needs development of a reliable traffic engineering monitoring and forecasting system and self-correcting spectrum allocations nationwide.**

Interruptible-shared spectrum can exploit the “naturally” occurring ebbs and flows in spectrum use between disparate user types. There is also a need for a universal schema for roaming and authentication for public safety access across both dedicated public safety spectrum bands and commercial bands to resolve interoperability and coverage issues, and to create a national architecture for public safety communications. When a first responder is out of coverage of their primary system, the receiver equipped with roaming capability could identify available channels and transmit and receive over a commercial or alternate public safety system as an authenticated “guest subscriber.” While this concept may involve spectrum leasing as envisioned in the report and order, it may be quite different. The approach recommended here is a series of subscriber agreements, like a nationwide roaming model, that would allow a legitimate in-service public safety receiver to transmit over any available frequency.

Employing a traffic monitoring and forecasting system shared over multiple system operators would allow dynamic spectrum rights (perhaps using spectrum leasing) to meet predictable levels of demand, and to adjust to unpredicted disaster response requirements. Cognitive, or aware, radio technology provides radios the capacity to sense the environment, such as the ebbs and flows of spectral availability, and to adjust spectrum usage accordingly.

We recognize that cognitive radios are in the early stages of development, and not yet available to public safety. WiNSEC suggests that a series of efforts in policy, legal, and economic research are necessary to lay a sound foundation and framework for further development in cognitive and software defined radio design, spectrum leasing schemes and band management. WiNSEC suggests that the FCC encourage commercial radio systems, through spectrum policy and equipment standards, to recognize and authenticate public safety access. The idea is to end the development of “public safety” hardware, and the isolation of public safety communications. Instead we need to provide both exclusive public safety bands and accessibility to commercial backbones that will not only accommodate, but also prioritize public safety access.

Development of policies, data, and practices that do not preclude, and in fact promote, interruptible-preemptive spectrum use for public safety entities will be a first step in allowing the individual communities of this country to find their independent means for enhancing public safety communications.